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OPERATION
AND
SERVICE MANUAL

Telonic® INSTRUMENTS

Division of Telonic Industries, Inc.

WARRANTY

TELONIC INSTRUMENTS AND ACCESSORIES

Products manufactured by TELONIC INSTRUMENTS; Division of Telonic Inductries, Inc. are guaranteed against defective materials and workmanship for a period of one year (vacuum tubes excepted) from date of purchase. This warranty does not apply to instruments that have been altered, improperly handled or damaged in any way beyond our control.

Instruments must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

CHANGES IN SPECIFICATIONS

The right is reserved to change the published specifications of equipment at any time, and to furnish merchandise in accordance with current specifications, without incurring any liability to modify equipment previously sold.

RETURNING EQUIPMENT TO FACTORY

Factory service is available for repair and readjustment of this instrument. However, a description of the trouble, plus the MODEL AND SERIAL NUMBERS of the unit must be forwarded FIRST, whereupon instructions for correcting the trouble OR authorization for returning the equipment will be given. This applies to all units, whether under warranty or not. Contact TELONIC INSTRUMENTS at Post Office Box 87, Beech Grove, Indiana 46107 or your local TELONIC representative.

MODEL L-4/L-4M
T.O.S. No. 109C
SERIAL NO.
PLUG IN OSCILLATOR

CONVERSION INFORMATION

Commencing with equipment shipped after about July 22, 1963, certain modifications have been incorporated in the Telonic SM-2000 plug-in series, and in the Telonic SM-2000 control chassis. These modifications may render the units incompatible with those previously shipped unless the earlier instruments are modified also. The equipment in which these modifications have been made can be identified by the letter "A" prefixed to the serial number.

Units not so identified must be modified if they are to be compatible with instruments now being shipped. The modifications to be made are listed below, divided into two groups - those to be made to earlier SM-2000's and those to be made to earlier plug-ins.

SM-2000 CHANGES

1. On J601, remove all wires presently connected to pin 8 and reconnect them at pin 7; remove the jumper between pins 7 and 8.

2. Using shielded wire, type RG-174/U or equal, connect pin 8 of J601 to the printed circuit board land which leads to pin 1, V303. Ground the shield by connecting it to a convenient ground land nearby.

3. Prefix the letter "A" to the serial number of the instrument.

PLUG-IN CHANGES

1. On P601 remove all wires presently connected to Pin 8 and reconnect them at pin 7; remove the jumper between pins 7 and 8 if one is connected.

2. Prefix the letter "A" to the serial number of the instrument, if none is prefixed.

Changing the serial number of the instrument is as important in the modification as are the electrical requirements, as the ability to identify a unit as having been or not having been modified is involved.

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SECTION I .. SPECIFICATIONS

INTRODUCTION

The L-4 is a plug-in sweep oscillator unit for use with the Telonic Models SM-2000 and SM-2000-1 control chassis. This plug-in utilizes the special functions of the control chassis such as choice of sweep/retrace ratio, variable sweep rate, and manual or external sweep.

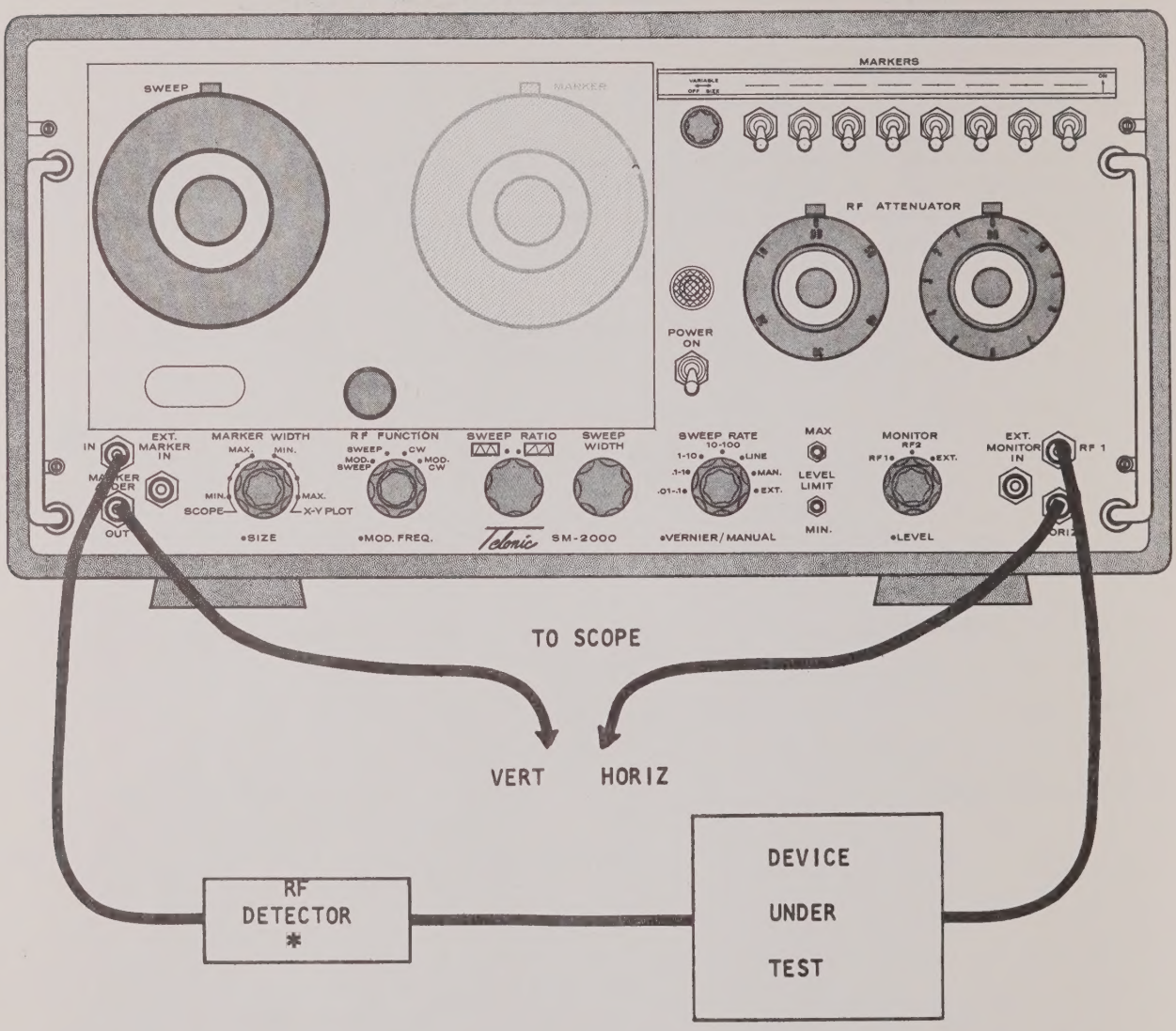
The L-4M includes a variable marker covering the entire swept frequency range. This difference is clearly indicated throughout the manual.

SPECIFICATIONS

CW AND SWEEP CENTER FREQUENCY RANGE	10-40 MHz
SWEPT FREQUENCY RANGE	6.25-55 MHz
SWEEP WIDTH	0.1-80%
OUTPUT VOLTAGE	1v rms into 50Ω
FLATNESS	±0.25dB
LINEARITY	
At 40% sweep width	1.2:1 or better
At maximum specified sweep width	2:1 or better
VERNIER LEVEL CONTROL RANGE	0-6dB
VARIABLE MARKER (L-4M only)	
Frequency range	5-60 MHz
Accuracy	±0.4%

SECTION II .. OPERATING INSTRUCTIONS

TYPICAL SET UP



*The Telonic XD-3A or XD-8A is suitable for this use in a 50Ω system. The XD-4A or XD-9A is recommended in a 75Ω system.

DESCRIPTION OF FRONT PANEL

The front panel contains two controls (one only if variable marker is not installed).

SWEEP — The Sweep Dial, which sets the center frequency of the sweep oscillator by means of a variable capacitor.

MARKER — The Variable Marker Dial, calibrated in three ranges to cover the full range of the unit. This control also adjusts frequency with a variable capacitor.

GENERAL

1. Make sure the control chassis power is OFF before inserting the plug-in oscillator into the control chassis. If the power is ON, transient voltages may damage diodes in the units. Insert plug-in oscillator and secure it in the chassis by tightening the fastening rod with the knob in the lower center of the front panel.

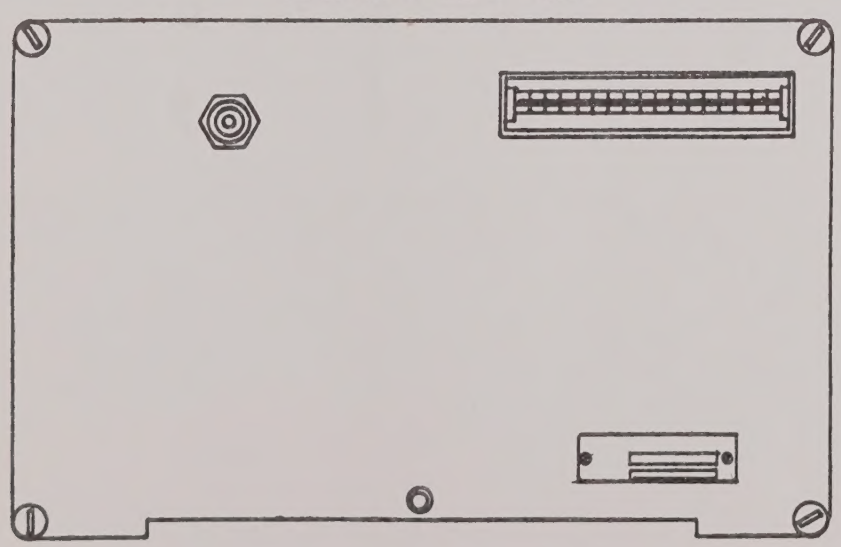
2. Make connections to the scope (or recorder), the device under test, and RF Detector as shown. All connectors located on the sweep generator are BNC type and it is recommended that RG cable be used for all connections. This insures good ground connection between the devices and minimizes hum, radiation from the unit, and pickup of spurious external signals. The cable that is used to connect RF 1 to the device under test should match the impedance of the sweep generator, or else a matching network should be used to insure a constant input signal.

3. Refer to the manual for the control chassis for additional instructions.

4. To insure proper operation refer to Section IV (CALIBRATION PROCEDURE). NOTE: To insure a constant amplitude signal, the LEVEL MAX and MIN controls on the control chassis should be set as prescribed in Section IV of this manual. This adjustment varies with the individual plug-in oscillator.

5. Proceed in accordance with recommendations of the manufacturer of the device under test concerning alignment, adjustment, and tests.

DRAWING OF REAR PANEL



DESCRIPTION OF REAR PANEL

The two electrical connectors on the rear panel are:
A BNC plug, which mates with a BNC jack on the control chassis. This is the RF output connector.

A 32-contact plug which makes the other electrical contacts necessary through a mating socket on the control chassis.

SECTION III .. GENERAL DESCRIPTION

SWEEP OSCILLATOR

The sweep oscillator is a push-pull circuit with inductive feedback and inductive coupling to the output.

The frequency is swept with a triangular or sawtooth drive (from the control chassis) to a saturable reactor which controls the inductance in the oscillator tank circuit. The oscillator tank capacity is controlled by the front panel SWEEP frequency dial.

The output is leveled by a signal from the control chassis as explained in the manual for that unit.

VARIABLE MARKER

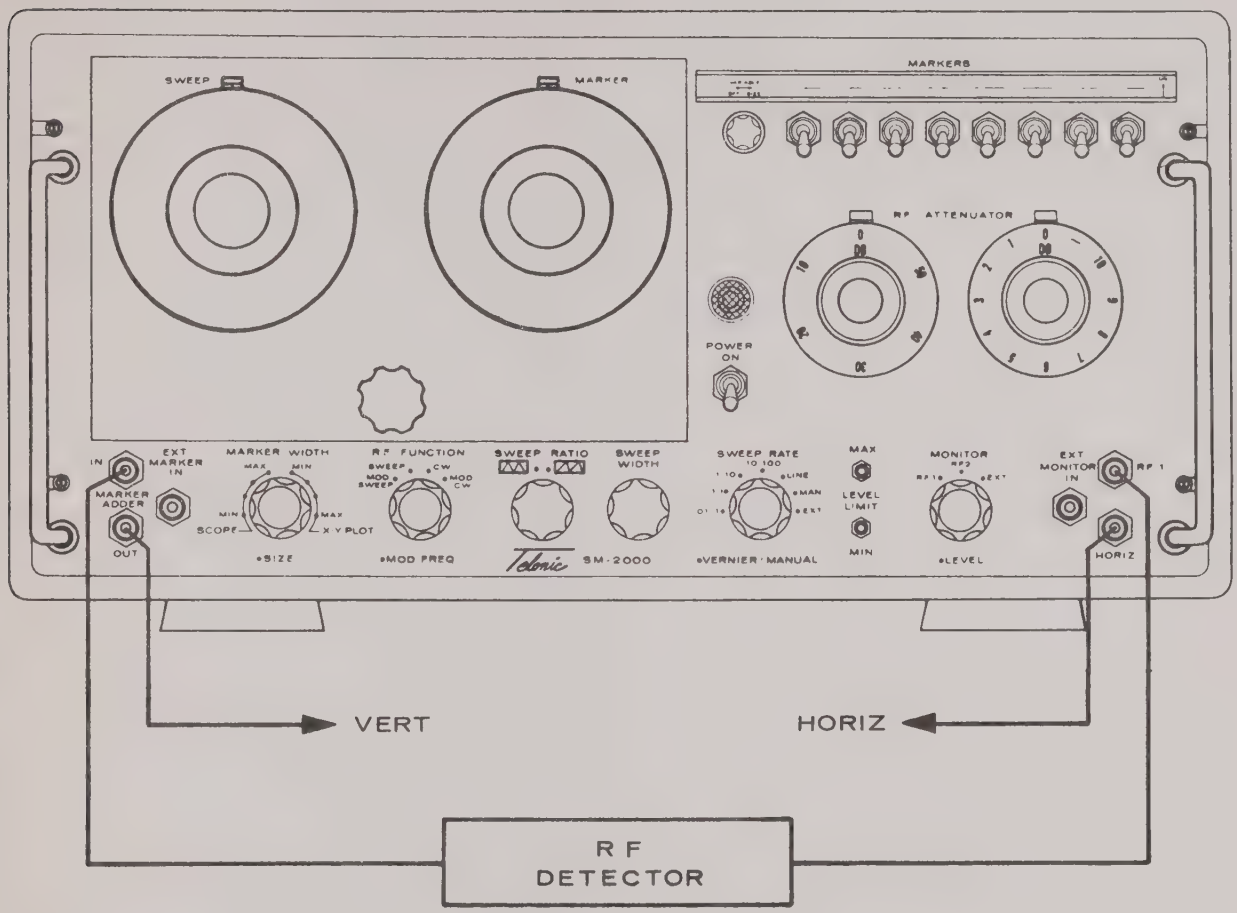
The variable marker is derived from heterodyning the fundamental or harmonic frequencies of a variable oscillator and the sweep oscillator. Each marker dial is calibrated over three ranges. The center range represents the fundamental band of the variable oscillator, which is somewhat less than that of the sweep oscillator. The outer and inner scales are respectively one-half and twice the fundamental, and the three scales together extend over the full swept range.

The diode mixer circuit which combines the signals from the two oscillators is also an effective harmonic generator. Thus there will be harmonics of both the sweep oscillator output and the variable c-w oscillator output present. In the lower end of the swept range the second harmonic of the swept signal heterodynes with the fundamental c-w signal to produce the birdy. In the upper part of the swept range the second harmonic of the c-w signal combines with the fundamental swept signal to produce the birdy. Over the fundamental range of the c-w oscillator the birdy is produced by heterodyning the fundamental signals from both oscillators.

The mixer circuit has been optimized carefully to produce a marker of approximately constant amplitude over the full range and to discriminate against spurious markers.

The output of the mixer is coupled to the birdy-by-pass marker system on the control chassis through a filter which limits the frequencies passed to those required for a birdy marker.

SECTION IV .. CALIBRATION PROCEDURE



TYPICAL SET UP

GENERAL

The following procedure should be applied after changing any component in the plug-in unit, or at any time the calibration is noted to be incorrect.

Complete calibration of the plug-in involves adjustment of three different classes of controls:

Those located in the plug-in which affect the operation of the control chassis.

Those located in the plug-in and affecting plug-in functions only.

Those located in the control chassis which affect the operation of the plug-in.

The latter class of controls is discussed in the manual for the control chassis. The others are treated here.

NOTE: Although preliminary adjustments may be made with the cover removed from the oscillator section, final adjustment requires that the bottom cover be in place. See chassis layout drawing for location of internal adjustments.

TEST EQUIPMENT REQUIRED

Calibrated RF Detector (such as the Telonic XD-3A)
Oscilloscope
In addition, crystal-controlled harmonic markers, such as the Telonic "CDH" series, are required. A CDH-10 and a CDH-1.0 are recommended.

PROCEDURE

1. Make connections as shown on typical setup. Observe the instructions contained in Section II concerning type of cable.

2. With power off, insert the plug-in and secure it in place.

3. Turn the power on, allow a 15-minute warmup period, and make adjustments as outlined.

MIN CENTERING (Adjustment)

The MIN CENTERING control is set for optimum dial accuracy at minimum sweep width.

Set the front panel SWEEP WIDTH control near minimum. Turn on the 10-MHz harmonic marker. Turn off the variable and all other markers.

Set the SWEEP dial to 10 MHz.

Adjust MIN CENTERING to center the first marker on the trace. Now decrease the sweep width slowly to minimum, maintaining the center of the marker in the center of the trace with the MIN CENTERING control.

Similarly check the dial at any other frequencies of interest, adjusting MIN CENTERING to divide errors if necessary. If preferred, this control may be set instead to provide best dial accuracy at a critical frequency.

MAX CENTERING (Adjustment)

This control is set to keep the "center frequency" (dial setting) centered on the scope trace at maximum sweep width. Rotate the front panel SWEEP WIDTH control fully clockwise.

Set the SWEEP dial to 10 MHz. Turn on the 1-MHz harmonic marker. Locate the marker corresponding to the dial setting. Be sure all other marker units are turned off.

Adjust MAX CENTERING so that the marker corresponding to the dial setting is centered on the trace.

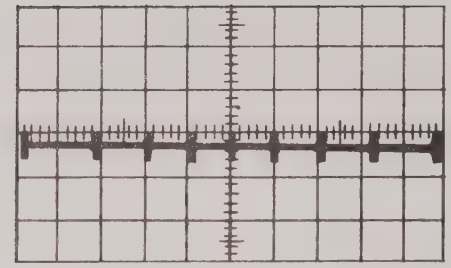
SWEEP WIDTH (Adjustment)

This adjustment is set to provide the specific maximum sweep width. These plug-ins have an essentially constant percentage of sweep width over the full range, and the frequency at which the sweep width adjustment is made can be chosen for a convenient marker display.

Leave other controls set as above and turn on the 1-MHz harmonic marker. When the plug-in SWEEP WIDTH control is set properly, there will than be 9 markers on the display. Alternately adjust the sweep dial and sweep width control until the two outer markers are at the exact ends of the trace. See figure on the following page.

NOTE: The SWEEP dial is calibrated at minimum sweep width and, at the conclusion of this adjustment, may not read the exact frequency originally set

Now readjust MAX CENTERING, then MIN CENTERING, as above if necessary to recalibrate this mark on the SWEEP dial.



LINEARITY

Linearity measurements are made over the center 80% of the display at maximum sweep width.

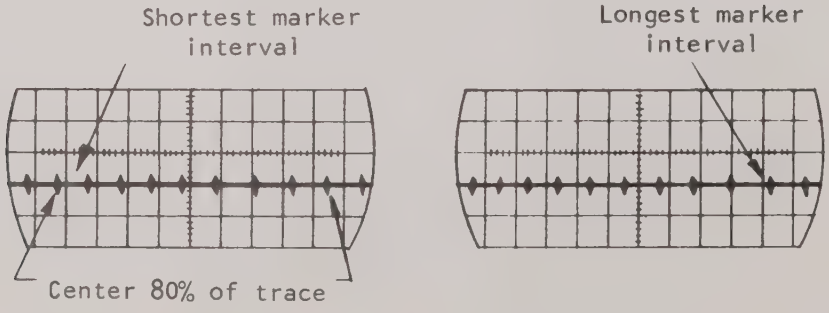
With other controls set as above turn on the 1 MHz harmonic marker. Turn off all other markers. Set the SWEEP dial for a center frequency which will allow 10 marker intervals to occupy the full trace and adjust the harmonic gain of the oscillator for a 10 cm trace.

Locate the shortest and longest marker interval in the center 80% (8 cm) of the oscilloscope trace. Readjust the horizontal gain of the oscilloscope so that the shortest interval occupies exactly 1 cm. See figure below.

Adjust the position of the trace so that the longest marker interval begins on a graticule line and measure the length of the interval. See figure on the right below.

Its length in centimeters indicates the linearity ratio: a length of 1.15 cm for the longest marker interval represents a linearity of 1.15:1.

Linearity can be checked at other sweep widths, such as 40%, by analogous methods using either the same or other harmonic markers.



CALIBRATION PROCEDURE

LEVEL LIMIT (MAX and MIN) (Control Chassis)

Preset the following controls on the control chassis:

LEVEL fully clockwise
SWEEP WIDTH fully clockwise
MONITOR in RF 1 position
SWEEP RATE to maximum
SWEEP RATIO to

Set the output level at exactly 1v rms with the MAX LEVEL LIMIT. Considering the efficiency of the XD-3A at this level and frequency, 1.0v rms corresponds to an XD-3A d-c output of about 1.1v. Insert fixed attentation, not to exceed 6 dB in an amount equal to the desired range of the LEVEL Control and note the output level. Reset the attenuators to 0 db, and rotate the LEVEL Control fully counter-clockwise. Adjust MIN LEVEL LIMIT for the same output noted with 6 dB fixed attenuation.

FLATNESS CHECK

Flatness is measured over the entire swept range of the plug-in; in this range, the minimum output must be not more than 0.5 dB lower than the maximum output at any frequency setting.

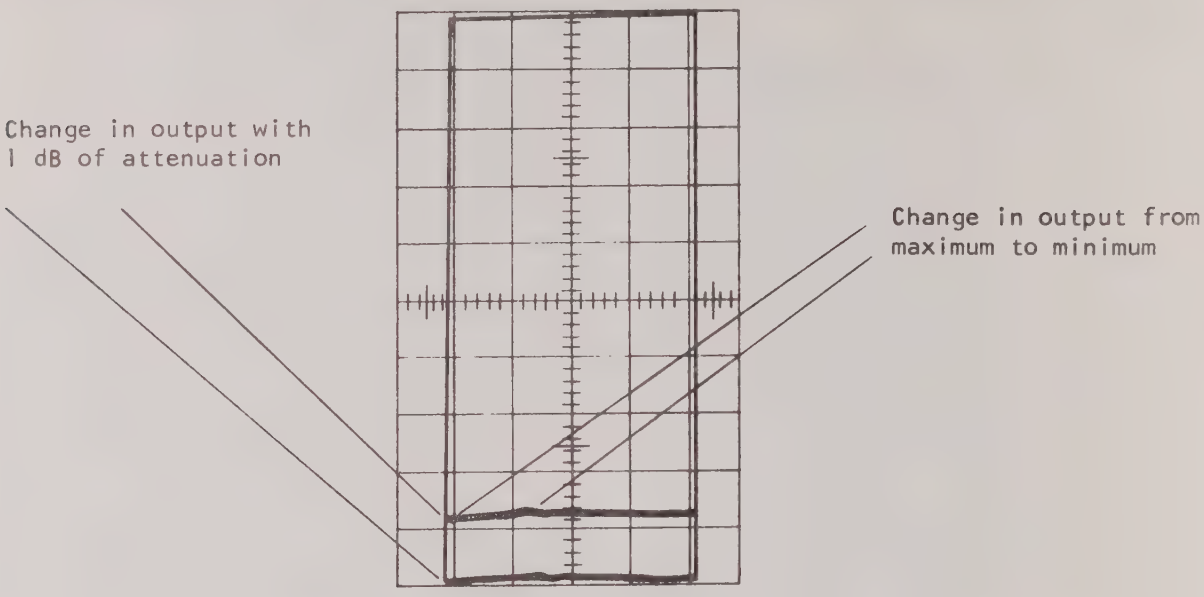
Preset the following controls:

SWEEP WIDTH fully clockwise
LEVEL fully clockwise
All markers OFF
MONITOR SELECTOR to RF 1

NOTE: Be sure that LEVEL MAX and MIN Controls are adjusted as prescribed above.

Rotate the SWEEP Dial through its calibrated range, noting the maximum and minimum outputs.

Compare the difference between these outputs with the reduction in output resulting from the insertion of 1 dB attenuation. The difference between the maximum and minimum must be no greater than half the change caused by the 1 dB attenuation.



VARIABLE MARKER (Adjustment)

This procedure is provided primarily to restore the dial accuracy after a component in the marker circuit is changed.

NOTE: Refer to chassis layout drawing for location of C804 and L801. These adjustments are made with the bottom cover ON.

Preset the following controls:

Control Chassis
- SWEEP WIDTH to approximately 10%
- LEVEL to maximum
- 10-MHz marker ON
- 1-MHz marker ON

Plug-in
- SWEEP Dial and MARKER Dial to the lowest frequency calibrated on center scale of MARKER Dial.

Adjust L801 to superimpose the variable marker over the crystal-controlled marker at this frequency.

Reset the plug-in SWEEP and MARKER dials to the highest frequency calibrated on the center scale of the MARKER dial.

Adjust C804 to superimpose the variable marker over the crystal-controlled marker at this frequency.

Repeat the above procedures until the markers are superimposed at each end of the frequency range each time the dials are set as prescribed. If preferred, dial errors can be divided over the full range instead, or a critical frequency can be favored with best accuracy.

SECTION V
MAINTENANCE

GENERAL PROCEDURE

Since this model is a plug-in unit, many of the possible malfunctions of the oscillator are the result of part failure in the control chassis. The connections at P601 of the plug-in and at J601 of the control chassis afford a convenient means of tracing the source of troubles to the oscillator or chassis.

In locating troubles which have been traced to the oscillator, application of the common rules of electronic maintenance, including a visual check for damage, open filaments, glowing anodes, shorted tuning capacitors, and charred resistors, is an obvious measure. All connectors, particularly P601 and J601, should be checked for cleanliness.

EXTENSION CABLE

For maintenance work requiring access to parts located on the under side of the plug-in, or in other areas not easily reached, an extension cable may be obtained from Telonic Industries, Inc. This cable, having the 32-contact plug on one end and the 32-contact jack on the other, allows the plug-in to be removed from the control chassis and operated on the bench.

ACCESS TO R-F COMPARTMENT

There are four unlacquered screws on the cover to the r-f compartment. Only these should be removed in taking off the cover.

The lacquered screws hold the shield in place and have nothing to do with securing the cover.

The following chart will be of service in deciding whether a trouble lies in the oscillator or control chassis. It is assumed that the above procedures have been applied and that the jumpers on P601 are intact. Where "inconclusive" is shown, the next step should be followed.

SYMPTOM	CHECK (on P601)	IF RESULT IS	PROBABLE TROUBLE	
			OSCILLATOR	SM-2000
Weak or no output or unleveled output	DC voltage at Pin 31 with RF LEVEL fully clockwise	High 100-175v	X	
		Low or zero 0-100v		X
No sweep width	1. Voltage Waveform, Pin 14 to ground.	Sawtooth or Triangular waveform 0v or DC voltage	X Inconclusive - see check #2	
	2. Next-resistance between Pins 14 and 15, 28 and 29, 30 and 4 with plug-in removed.	Open on any check	X	
		Continuity		X
Changing sweep width also changes center frequency	Resistance from Pin 28 to Pins 5,29, and 16 with plug-in removed.	Open on any check	X	
		Continuity		X
No variable marker	1. For birdy at Pin 17	Birdy present No birdy		X Inconclusive - see check #2
	2. DC voltage at Pin 1	100V Low or no voltage	X	X

If the chart shows that the trouble probably is in the control chassis, refer to the Maintenance Section of the manual for that unit.

If the trouble appears to be in the plug-in, the following chart may be of assistance in localizing the failure:

SYMPTOM	CHECK
Weak or no output or unleveled output	V701 and associated circuitry. Continuity from Pin 31 of P601 to Pin 1, 6, or 7 of V701.
No sweep width	Check R602, R603, R605, and L701A.
Changing sweep width changes center frequency	Check R601, R604 and R606 first for open, second for changed value.

SYMPTOM	CHECK
No variable marker	Check V801 and associated circuitry, including sweep sample line. Change diode in mixer circuit and check other mixer components.
Weak Marker	Diode in mixer circuit. V801 and associated circuitry. Sweep sample line. If markers on one range are considerably more prominent than those on another, substitute diodes to optimize all.
Spurious Markers	Check mixer diode and change if necessary. Be sure diode is inserted with correct polarity.

SECTION VI PARTS LIST

CIRCUIT REFERENCE NO.	DESCRIPTION	TELONIC PART NO.
C601	CFC (SC)	
C602	CFC (SC)	
C701	CFCF, 1000pf, +100-0%, 500VDCW	C-110
C702	Same as C701	
C703	Same as C701	
C704	Same as C701	
C705	CVA, dual, 14.0 to 522.6pf max	C-454
C706	Same as C701	
C707	Same as C701	
C708	Same as C701	
C709	Same as C701	
J701	RJ, UG-625/U	J-7
P601	Plug, 32-contact	S-39
P701	PC, UG-88C/U	J-13
P702	PC	J-27
L701	Reactor, saturable	A808-187
L702	Not Assigned	
L703	Not Assigned	
R601	RVC, 50KΩ, ±10%, 2W	R-751
R602	RVC, 250Ω, ±10%, 2W	R-771
R603	RFC, 1W (SC)	NA
R604	RFC, 12KΩ, ±10%, 1/2W	R-119
R605	RVC, 250KΩ, ±20%, 2W	R-752
R606	RFC, 68KΩ, ±10%, 1/2W	R-51
R607	Not assigned	
R608	SC	
R609	RFC, 33KΩ, ±10%, 1/2W	R-36
R701	RFC, 4.7KΩ, ±10%, 1/2W	R-21
R702	RFC, 39KΩ, ±10%, 1/2W	R-26
R703	RFW, 2.7KΩ, ±5%, 5W	R-413
R704	Same as R701	

CIRCUIT REFERENCE NO.	DESCRIPTION	TELONIC PART NO.
V701	TE, 6ES8	VT-52
	Socket, tube, 9-pin	S-58
	Feedthru, lo-capacity (2 required)	MP-42
C801	CVA, dual, 14.0 to 522.6 pf max	C-454
C802	CFC, 15pf, ±10%, 1000VDCW	C-7
C803	Not Assigned	
C804	CVC, 3.5 to 13 pf	C-436
C805	CFC, 25pf, ±10%, 1000VDCW	C-9
C806	Not Assigned	
C807	CFC, 0.01μf, +80-20%, 500VDCW	C-20
C808-C812	CFCF, 1000pf, +100-0%, 500VDCW	C-110
CR801	DS, 1N82	D-1
L801	IV	09101
L802	Not Assigned	
L803	IF, 55μh	L-108
L804	IF, 10μh	L-107
R801	RFC, 15KΩ, ±10%, 1/2W	R-66
R802	RFC, 1KΩ, ±10%, 1/2W	R-18
R803	RFC, 220Ω, ±10%, 1/2W	R-39
R804	RFC, 47KΩ, ±10%, 1/2W	R-27
V801	TE, 6AF4A or 6DZ4	VT-4 or VT-51
	Socket, tube	S-57
	Clip, diode	S-9

ABBREVIATION CODE

CFC	Capacitor, Fixed, Ceramic
CFCF	Capacitor, Fixed, Ceramic, Feedthru
CVA	Capacitor, Variable, Air
CVC	Capacitor, Variable, Ceramic
DS	Diode, Semiconductor
IF	Inductor, Fixed
IV	Inductor, Variable
PC	Plug, Cable
RFC	Resistor, Fixed, Composition
RFW	Resistor, Fixed, Wirewound
RJ	Receptacle, Jack
RVC	Resistor, Variable, Composition
SC	Subject to Change
TE	Tube, Electron

SECTION VII
SCHEMATIC DIAGRAMS

SCHEMATIC PART DESIGNATION

C	Capacitor
CR	Semiconductor diode
J	Jack
L	Inductor
P	Plug
R	Resistor, Fixed or Variable
V	Tube

SCHEMATIC VALUE ABBREVIATION

Ω	ohms
K	1,000 ohms
M	1,000,000 ohms (megohms)
µf	Microfarad
pf	Picofarad
µh	Microhenry
mh	Millihenry

OTHER ABBREVIATIONS

F.P.	Front Panel
R.P.	Rear Panel
T.P.	Test Point

RESISTORS - All resistors are 1/2 watt, ± 10%, and are shown in ohms, unless otherwise specified.

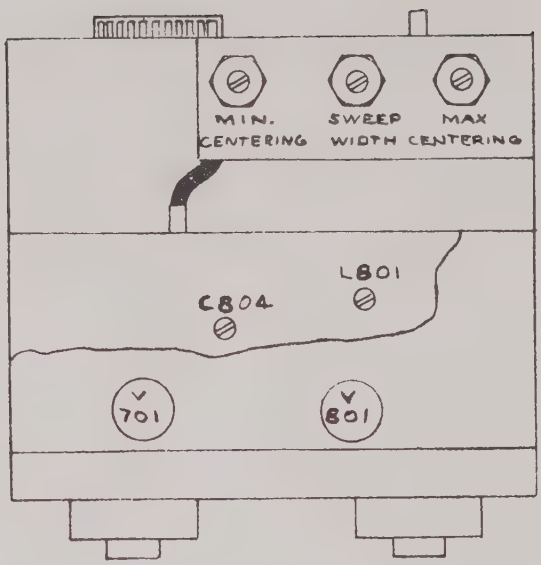
CAPACITORS - All capacitors are shown in picofarads (pf) unless otherwise specified.

COILS - All inductors are shown in microhenries (µh) unless otherwise specified.

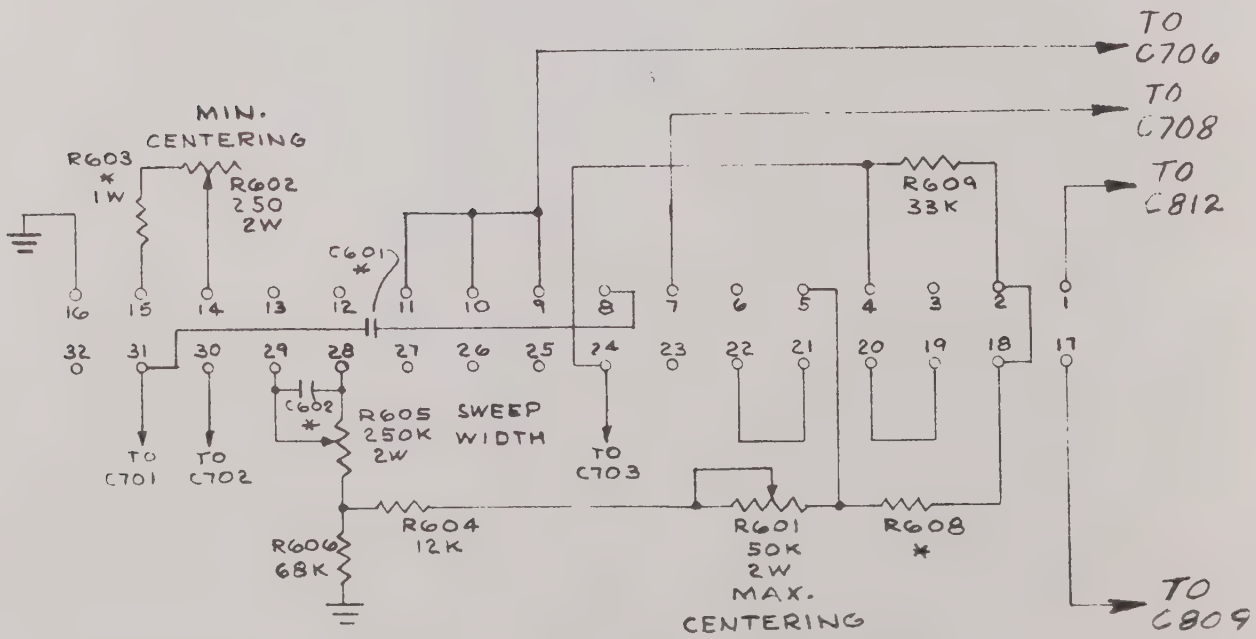
CIRCUIT REFERENCE SYMBOL - LOCATION INFORMATION

601-699	Interconnecting elements
701-799	Sweep Oscillator
801-899	Variable Marker

* Indicates value of component adjusted at factory, and may deviate from value shown on print.

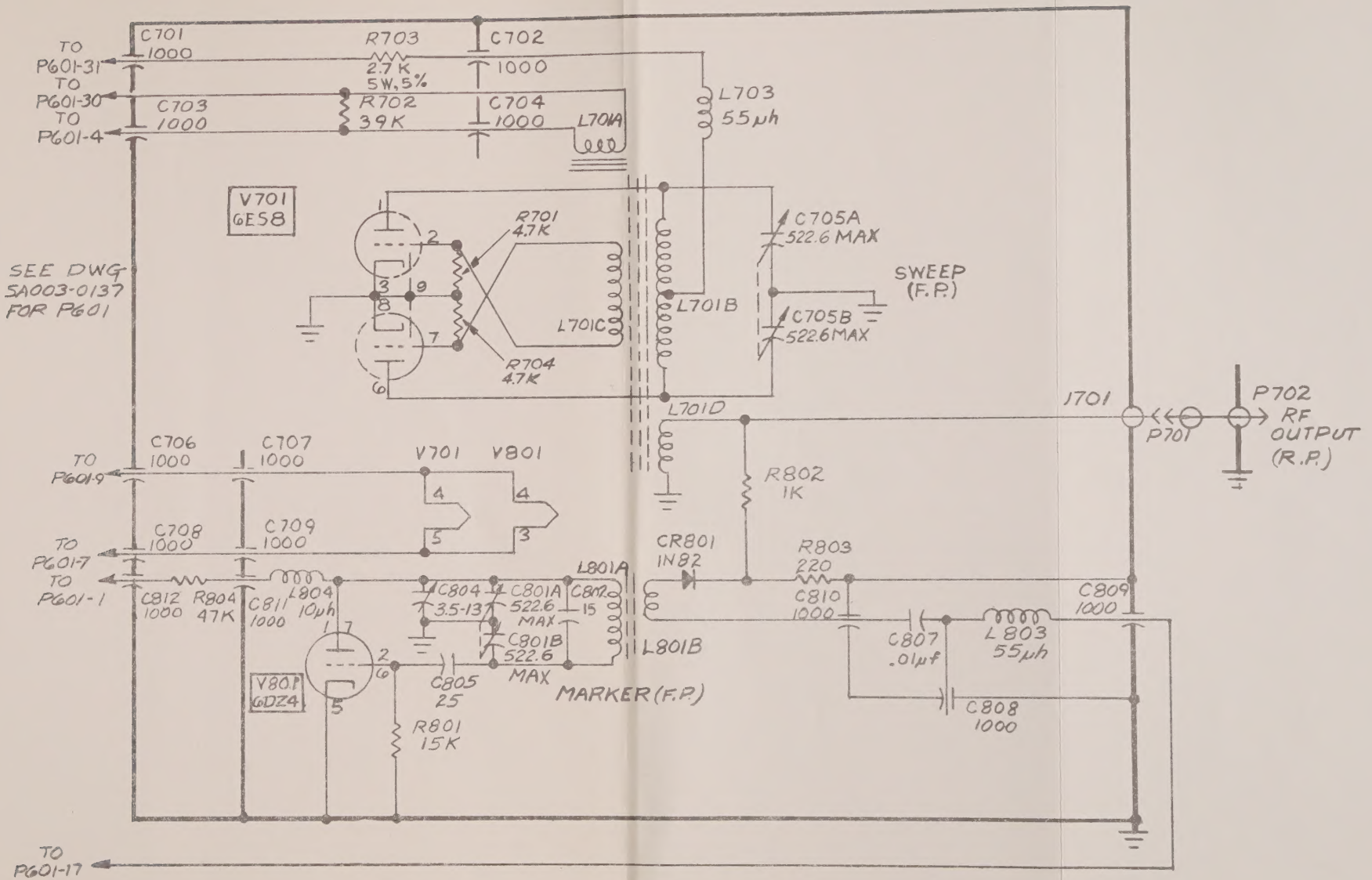


CHASSIS LAYOUT



P 601 CONNECTOR & CHASSIS LAYOUT

2471L
9/66



L-4M SCHEMATIC DIAGRAM